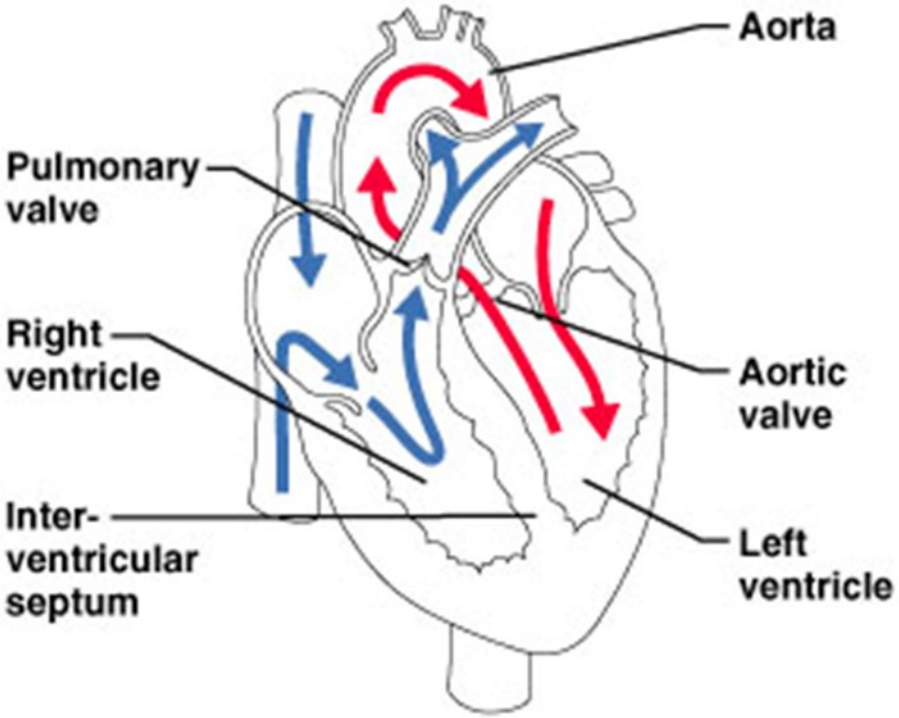
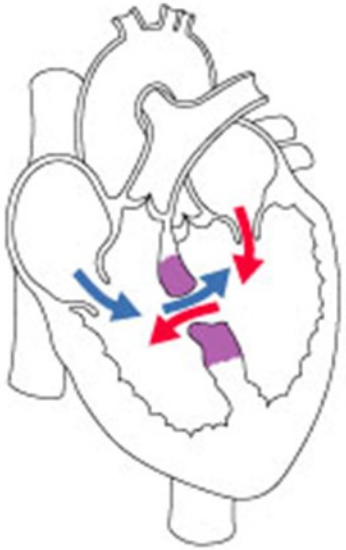
Circulation



(a) Normal heart. Arrows indicate the path of blood flow through the heart. Red = oxygen-rich blood; blue = oxygen-poor blood.

Congenital Heart Defects



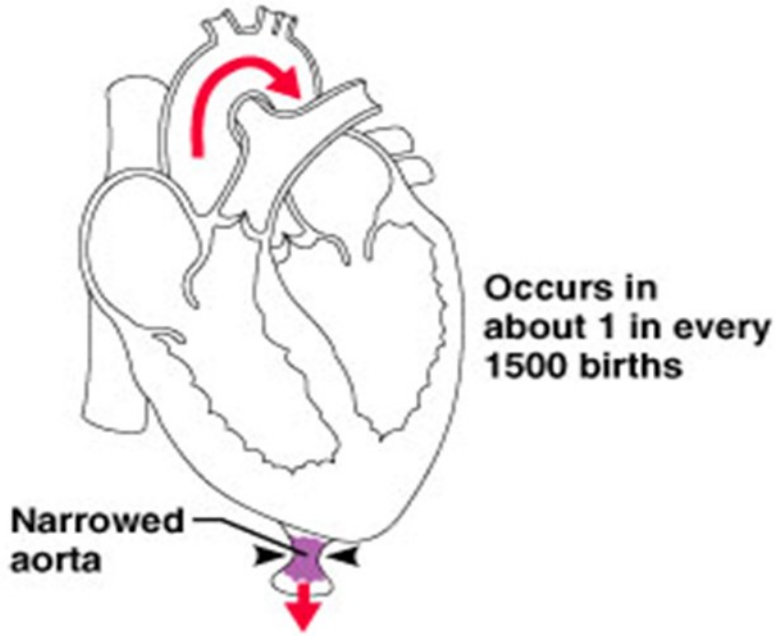
Occurs in about 1 in every 500 births

(b) Ventricular septal defect. The superior part of the interventricular septum fails to form; thus, blood mixes between the two ventricles.

Occurs in about 1 in every 1000 births

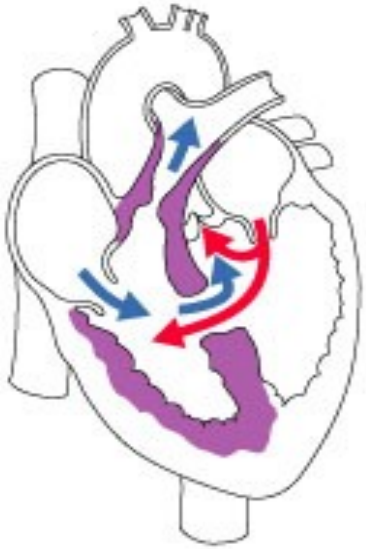
Transposition of the great vessels. Aorta comes from right ventricle, pulmonary trunk from left. Results when the bulbus cordis does not divide properly. Unoxygenated blood passes repeatedly around systemic circuit, while oxygenated blood recycles around the pulmonary circuit.

Congenital Heart Defects



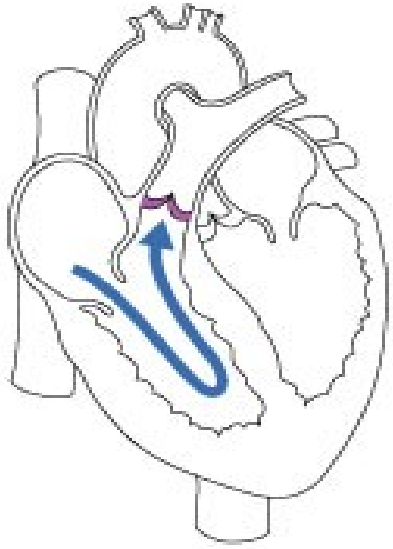
(d) Coarctation of the aorta. A part of the aorta is narrowed, increasing the work load on the left ventricle.

Congenital Heart Defects



Occurs in about 1 in every 2000 births

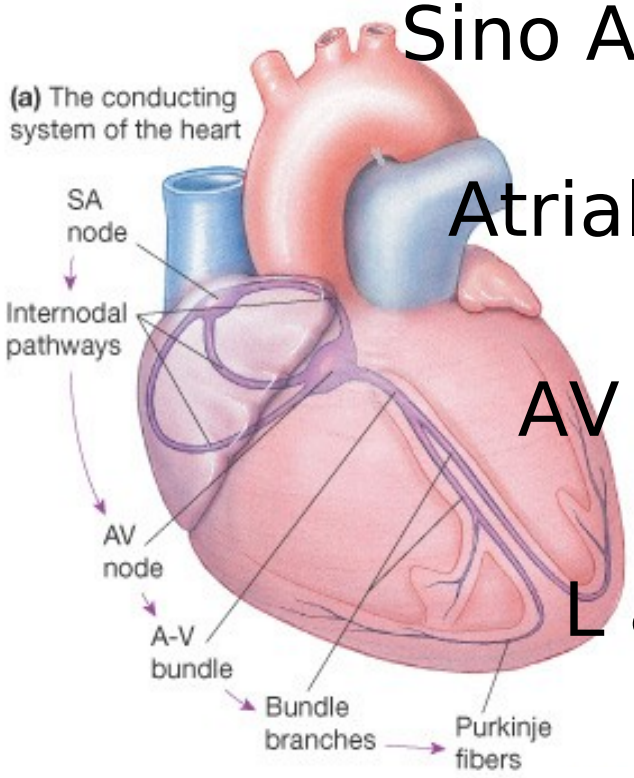
Tetralogy of Fallot. Multiple defects (tetra=four): Pulmonary trunk too narrow and pulmonary valve stenosed; ventricular septal defect; aorta opens from both ventricles; wall of right ventricle thickened from overwork.



Occurs in about 1 in every 2800 births

Pulmonary stenosis. The pulmonary semilunar valve is narrowed, lessening the flow of blood to the lungs.

Electrical Conduction System



Sino Atrial (SA) Node – sup/post rt atriun

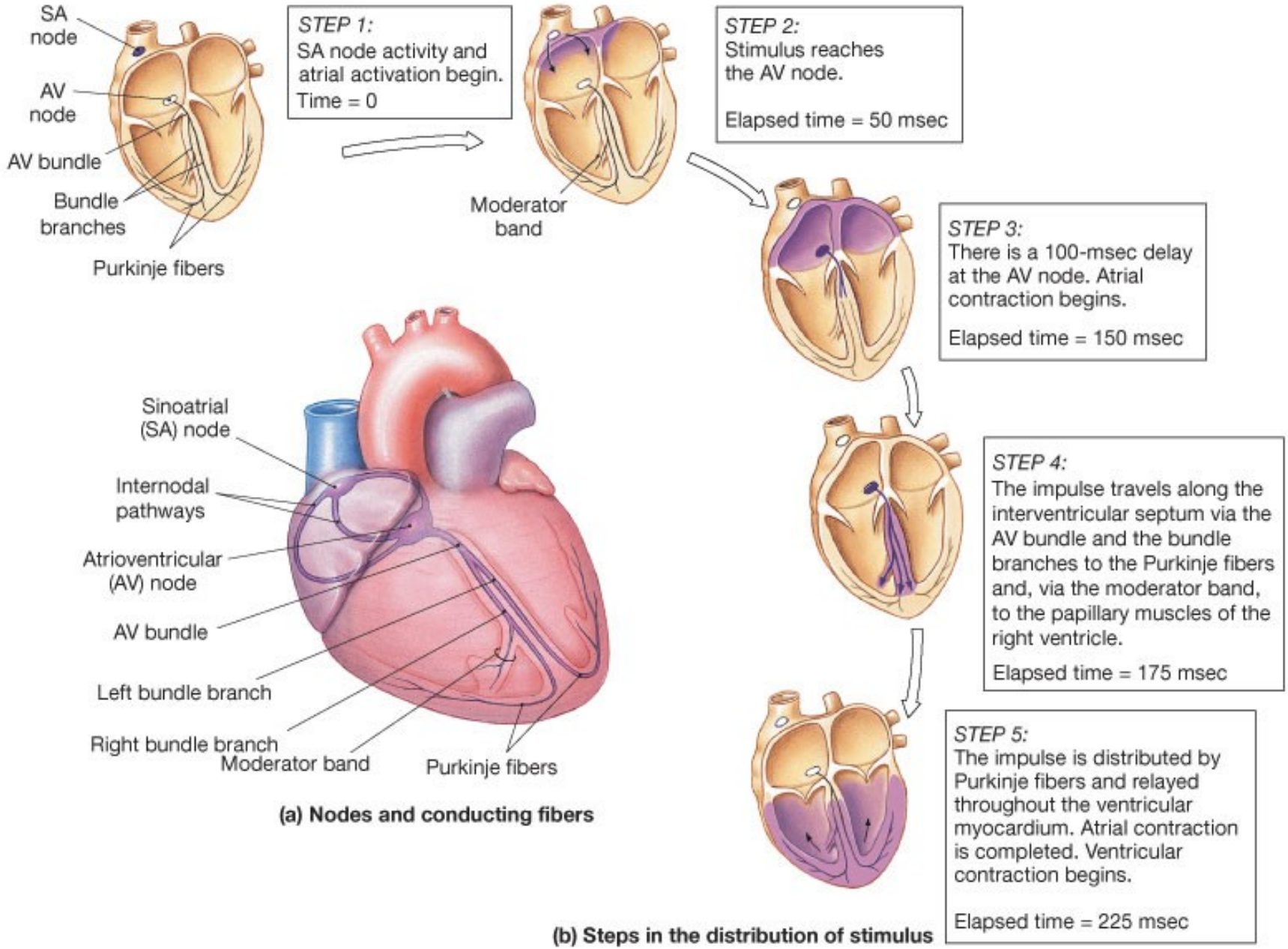
Atrial Ventricular (AV) Node – inf rt atri

AV Bundle (of His) – sup IV septum

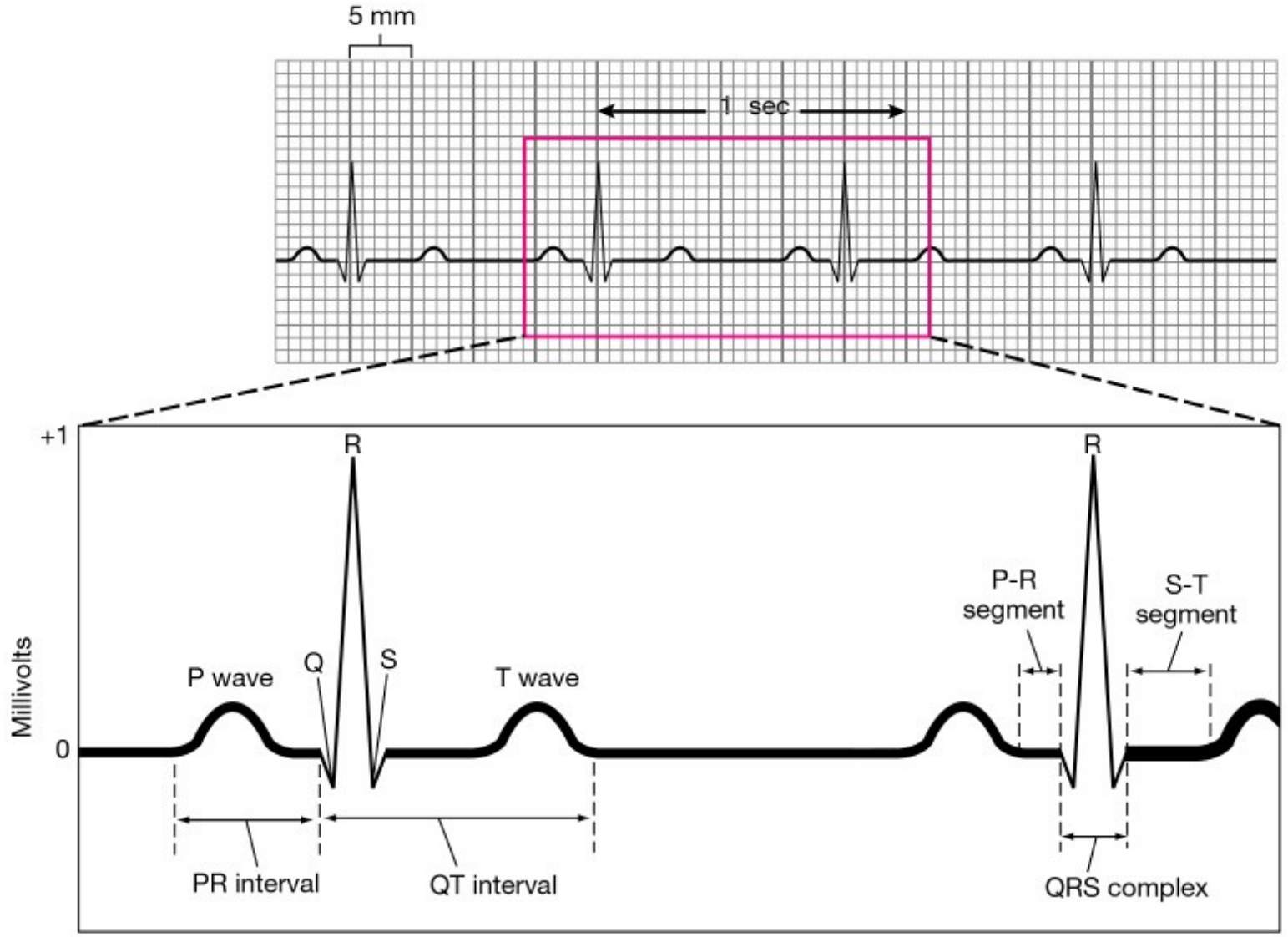
L and R Bundle Branches – IV septur

Purkinje Fibers – both ventricle

The Conducting System of the


SA node
AV node
AV bundle
Bundle branches
Purkinje fibers
STEP 1:
SA node activity and atrial activation begin.
Time = 0
Moderator band
STEP 2:
Stimulus reaches the AV node.
Elapsed time = 50 msec
STEP 3:
There is a 100-msec delay at the AV node. Atrial contraction begins.
Elapsed time = 150 msec
STEP 4:
The impulse travels along the interventricular septum via the AV bundle and the bundle branches to the Purkinje fibers and, via the moderator band, to the papillary muscles of the right ventricle.
Elapsed time = 175 msec
STEP 5:
The impulse is distributed by Purkinje fibers and relayed throughout the ventricular myocardium. Atrial contraction is completed. Ventricular contraction begins.
Elapsed time = 225 msec
Sinoatrial (SA) node
Internodal pathways
Atrioventricular (AV) node
AV bundle
Left bundle branch
Right bundle branch
Moderator band
Purkinje fibers
(a) Nodes and conducting fibers
(b) Steps in the distribution of stimulus

An Electrocardiogram (ECG) trace



The Electrocardiogram

Recording of the electrical activities in the heart

P wave

= Atrial Depolarization

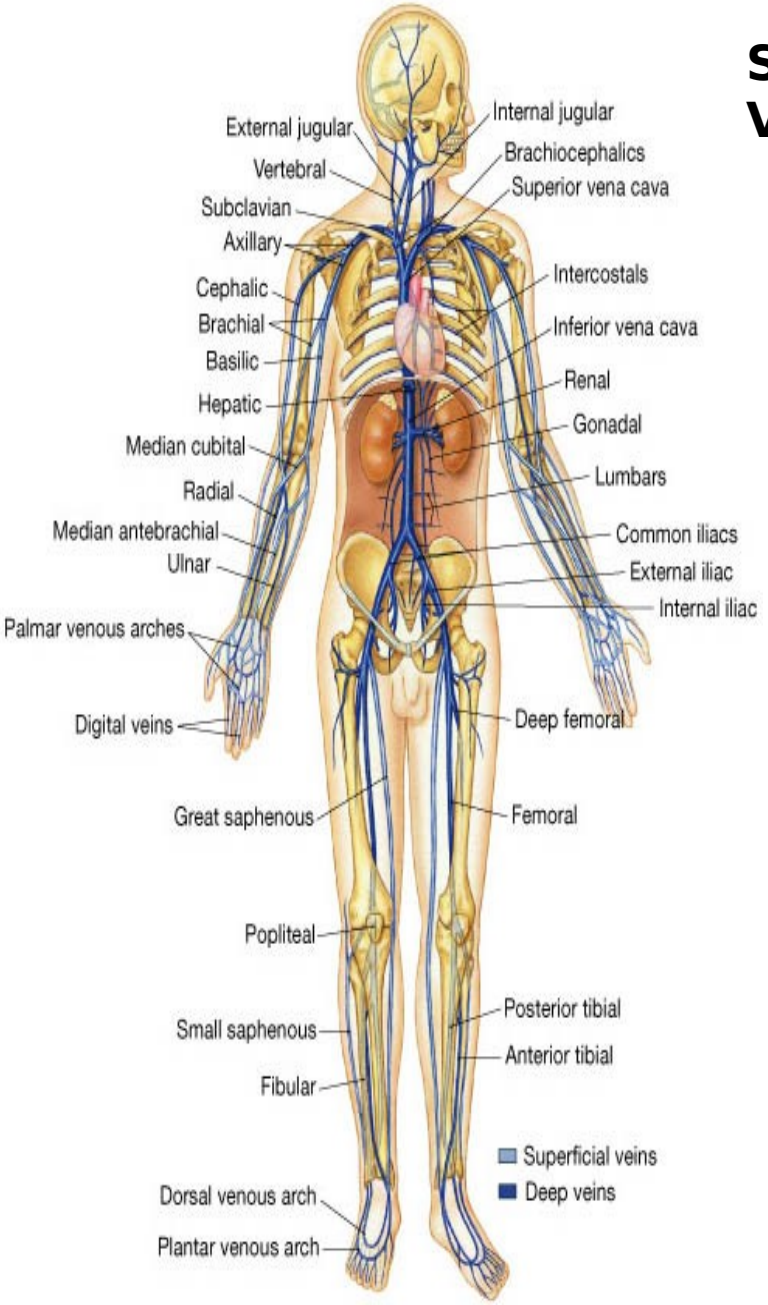
QRS complex

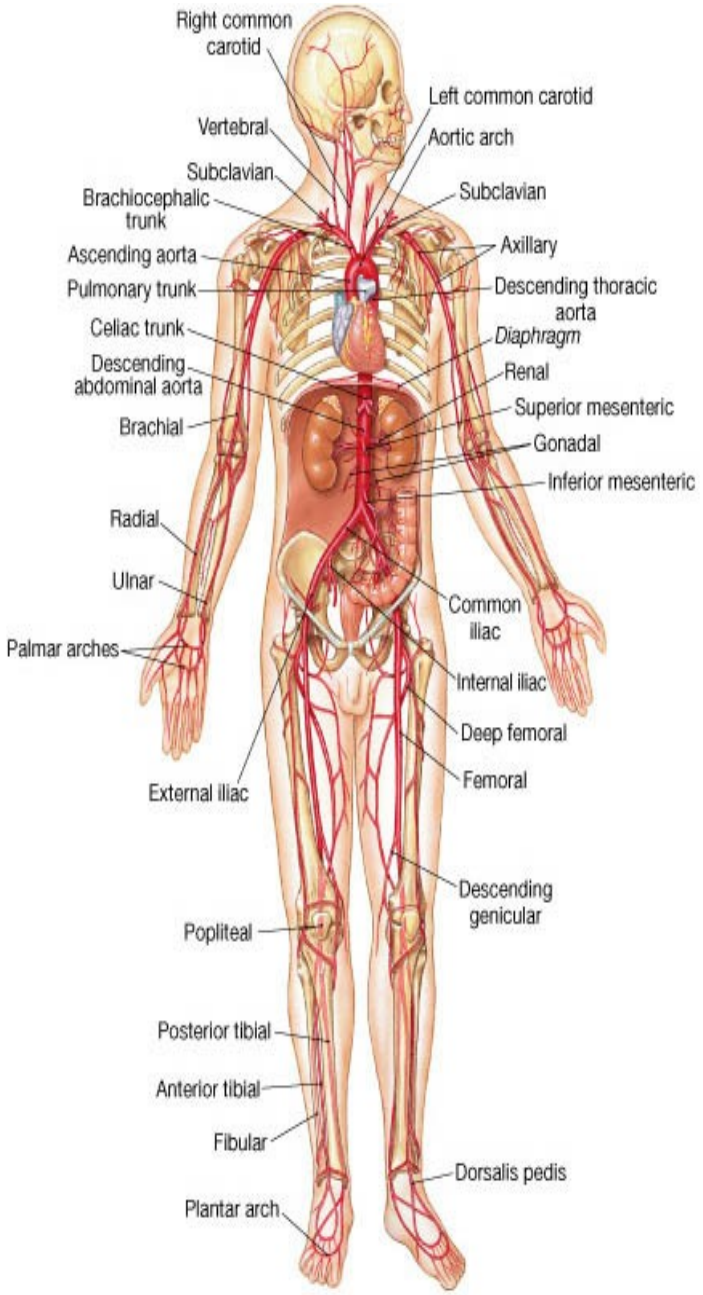
= Ventricular Depolarization

T wave

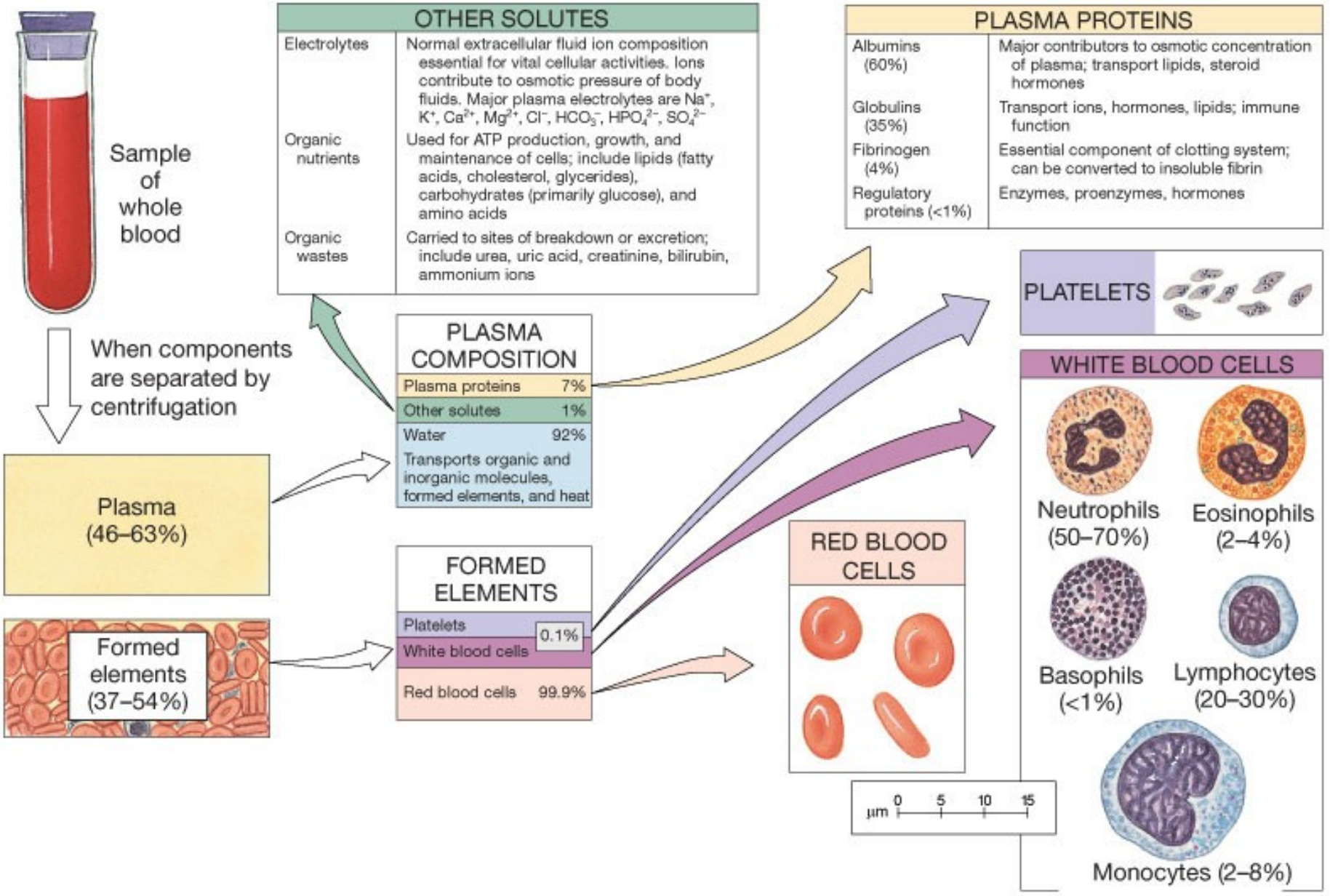
= Ventricular Repolarization

Systemic Vessels





Blood


Sample of whole blood
When components are separated by centrifugation
Plasma (46–63%)
Formed elements (37–54%)
OTHER SOLUTES
Electrolytes
Normal extracellular fluid ion composition essential for vital cellular activities. Ions contribute to osmotic pressure of body fluids. Major plasma electrolytes are Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, HPO_4^{2-}, SO_4^{2-}
Organic nutrients
Used for ATP production, growth, and maintenance of cells; include lipids (fatty acids, cholesterol, glycerides), carbohydrates (primarily glucose), and amino acids
Organic wastes
Carried to sites of breakdown or excretion; include urea, uric acid, creatinine, bilirubin, ammonium ions
PLASMA PROTEINS
Albumins (60%)
Major contributors to osmotic concentration of plasma; transport lipids, steroid hormones
Globulins (35%)
Transport ions, hormones, lipids; immune function
Fibrinogen (4%)
Essential component of clotting system; can be converted to insoluble fibrin
Regulatory proteins (<1%)
Enzymes, proenzymes, hormones
PLASMA COMPOSITION
Plasma proteins 7%
Other solutes 1%
Water 92%
Transports organic and inorganic molecules, formed elements, and heat
FORMED ELEMENTS
Platelets
0.1%
White blood cells
Red blood cells 99.9%
PLATELETS
WHITE BLOOD CELLS
Neutrophils (50–70%)
Eosinophils (2–4%)
Basophils (<1%)
Lymphocytes (20–30%)
Monocytes (2–8%)
RED BLOOD CELLS
µm 0 5 10 15

Blood = Plasma + Formed (Cellular) Elements

Plasma

- ~ 55% blood volume
- ~ 92% of plasma is water

- High dissolved O_2 content
- Dissolved proteins
- Minerals, glucose, ions.

Cells

- ~ 45% blood volume
- RBCs (~ 99% of cells)
- WBCs (~ 1% of cells)

The Proteins in Plasma

- **Albumins**
  - 60% of plasma proteins.
- **Globulins**
  - 35% of plasma proteins.
- **Fibrinogen**
  - For clotting reaction, forms *Fibrin*.

serum = plasma without clotting protei

Cellular Components

RBCs (erythrocytes) ~ 99% of all cells.

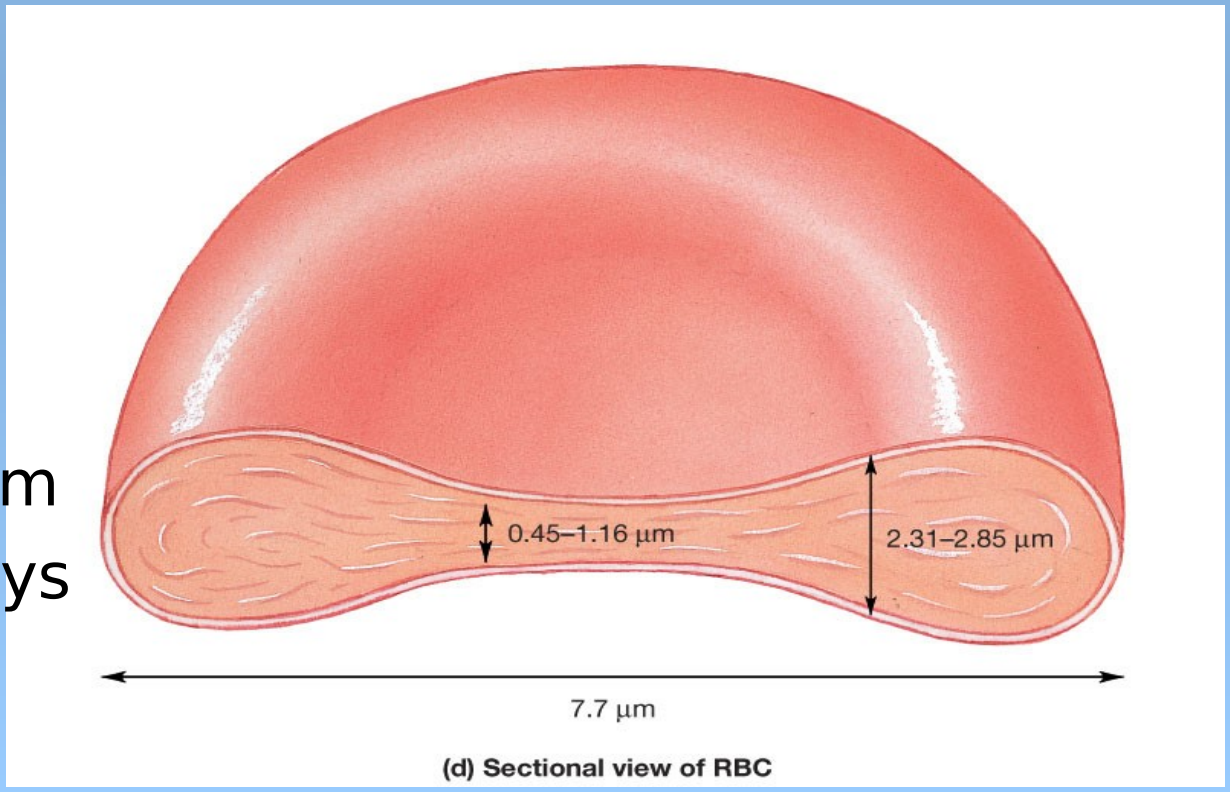
***tocrit* = % of blood occupied by cellular compo**

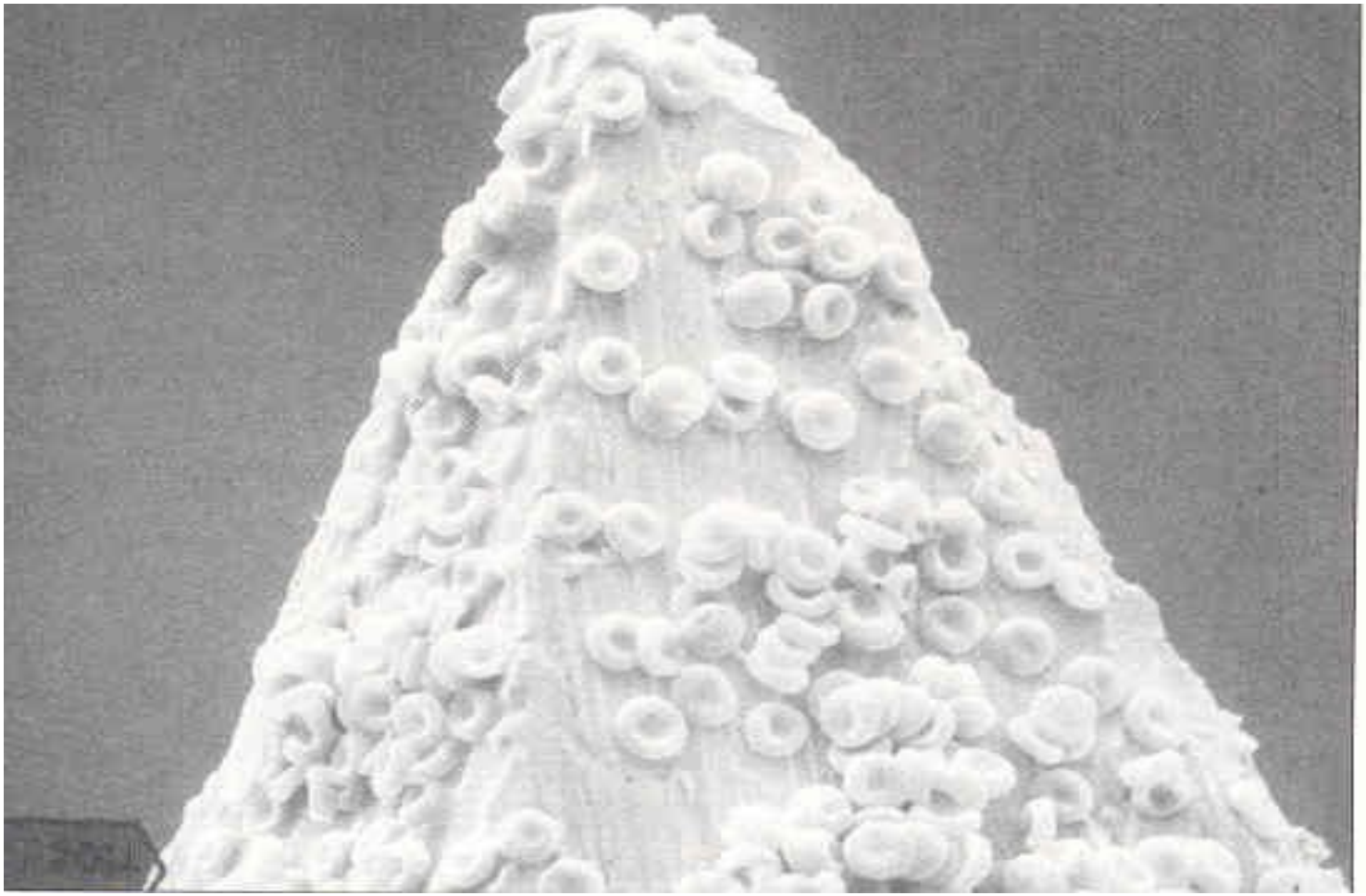
(packed RBC volume)

Lacks: nuclei, mitochondria and ribosomes.

Anaerobic metabolism

Life span = ~120 days





Scanning Electron Micrograph (SEM) of Erythrocytes or Red Blood Cells (RBCs) on the tip of a hypodermic needle.

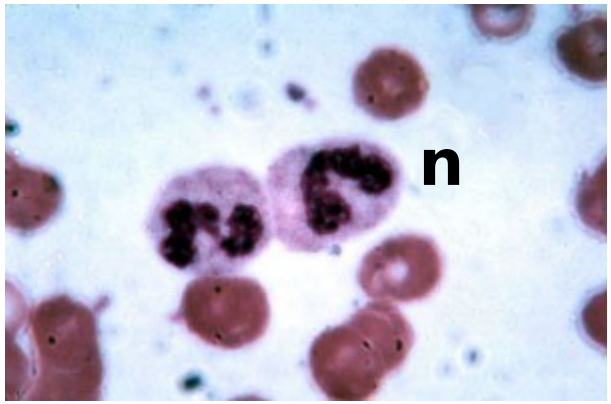
White Blood Cells (Leukocytes)

Granular Leukocytes

- **Neutrophils** *70% of circulating leukocytes*
  - Multi-lobed nucleus (3 or more), mobile phagocytes.
- **Eosinophils** *much less common*
  - Bi-lobed nucleus with '*orange*' staining granules.
- **Basophils** *relatively rare*
  - Bi-lobed with *dark* staining granules, releases histamine and heparin.

Agranular Leukocytes

- **Lymphocytes** *primary cell of lymphatic system*
  - **T-cells** attack foreign cells directly.
  - **B-cells** produce antibodies.
- **Monocytes**
  - Large ‘dimpled’ nucleus, differentiate into **Macrophages**.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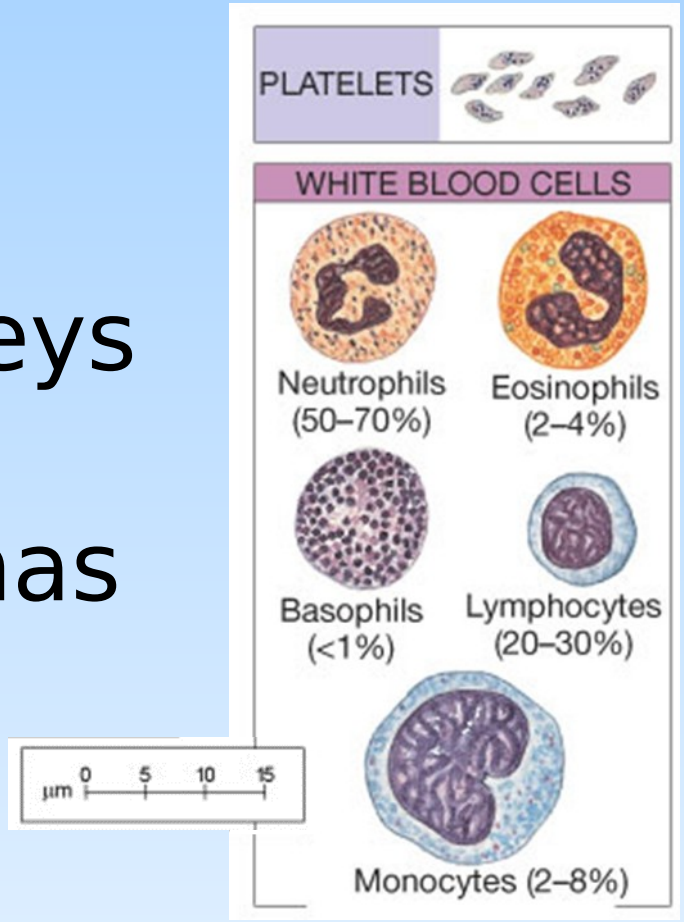
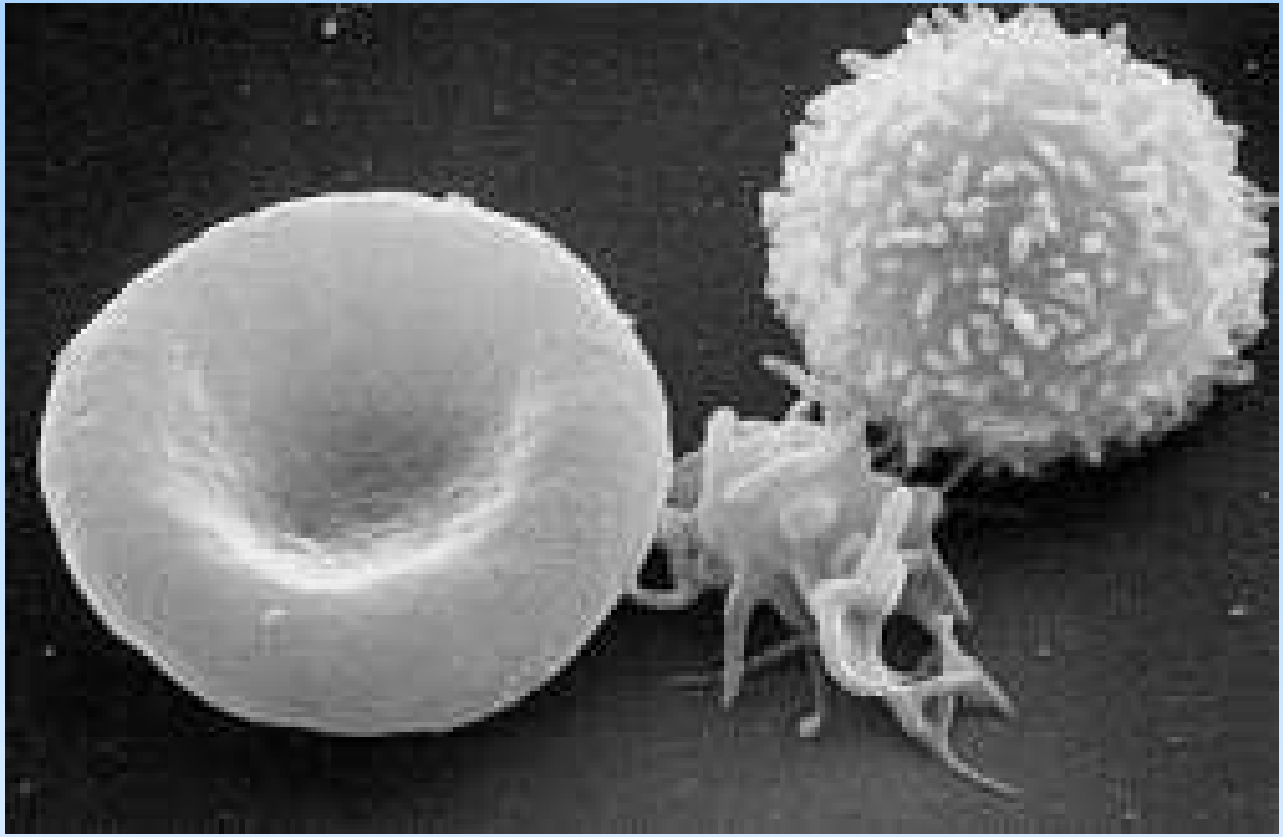
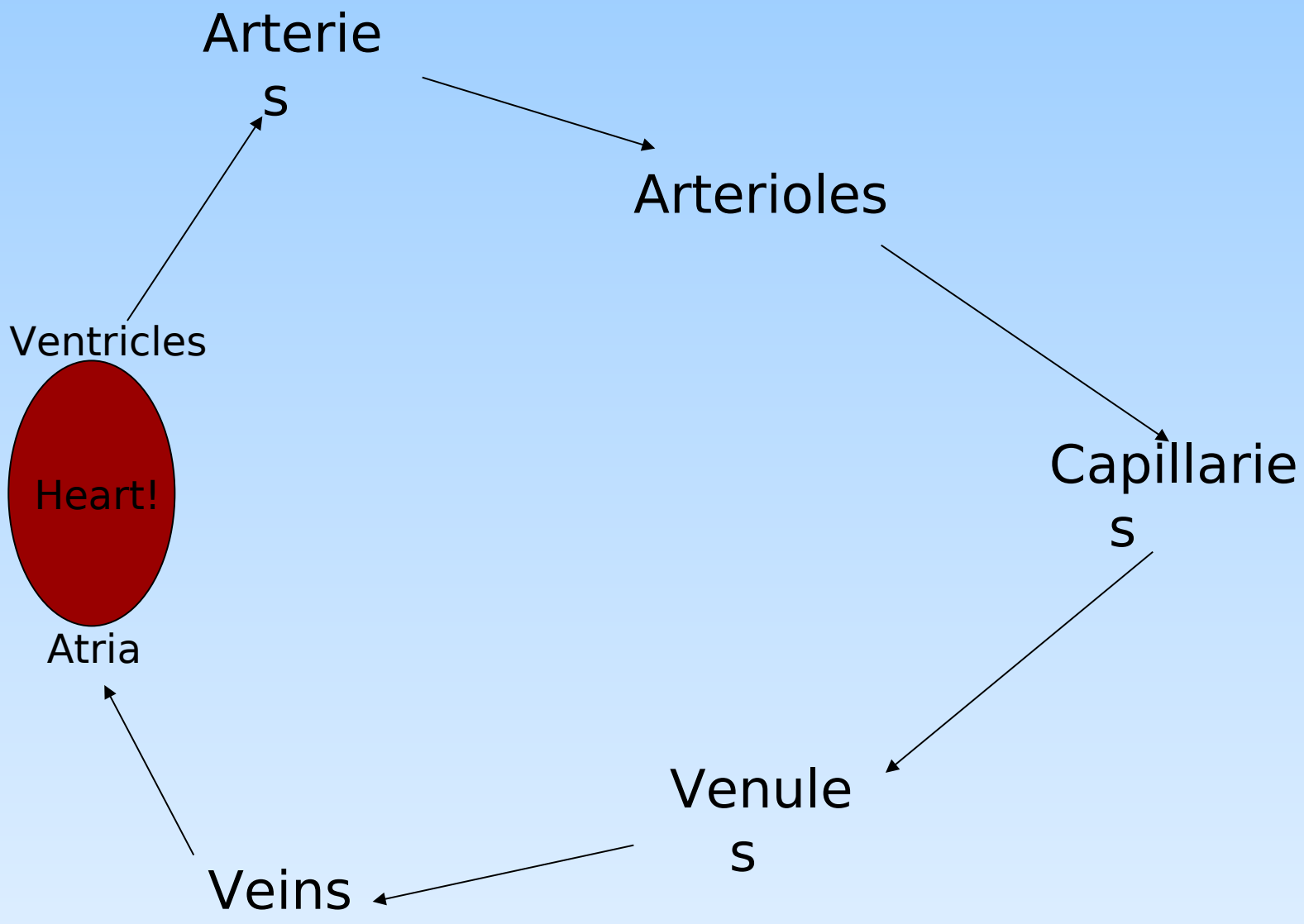
- **Platelet cells** (Thrombocytes)
  - Fragments of cells (Megakaryocytes) for clotting.

Never
Let
Monkeys
Eat
Bananas






Arteries
Arterioles
Capillaries
Venules
Veins
Atria
Heart!
Ventricles